

PIER PV Research Plan

Public Workshop

November 13, 2006

**Public Interest Energy Research Program
California Energy Commission**

Agenda



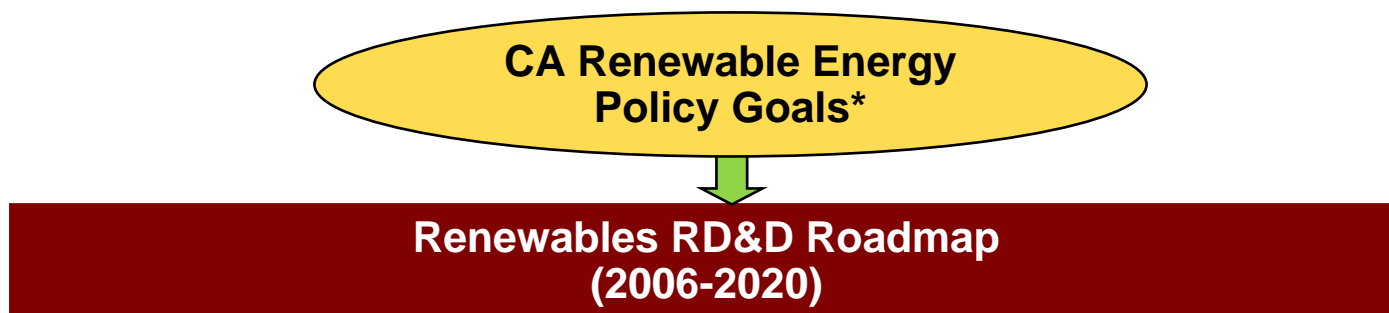
Introduction	<i>Elaine Sison-Lebrilla</i>	1:00 pm – 1:15 pm
PV RD&D at CEC and CPUC	<i>Elaine Sison-Lebrilla, Sandy Miller, Jeanne Clinton</i>	1:15 pm – 1:30 pm
PV RD&D Roadmap	<i>Elaine Sison-Lebrilla</i>	1:30 pm – 2:15 pm
Break		2:15 pm – 2:30 pm
PV RD&D Priorities for PIER	<i>Lisa Frantzis and Elaine Sison-Lebrilla</i>	2:30 pm – 3:45 pm
Closing	<i>Elaine Sison-Lebrilla</i>	3:45 pm – 4:15 pm

The purpose of today's workshop is to receive public comment on the PIER PV RD&D research plan.

The objectives for today's workshop are:

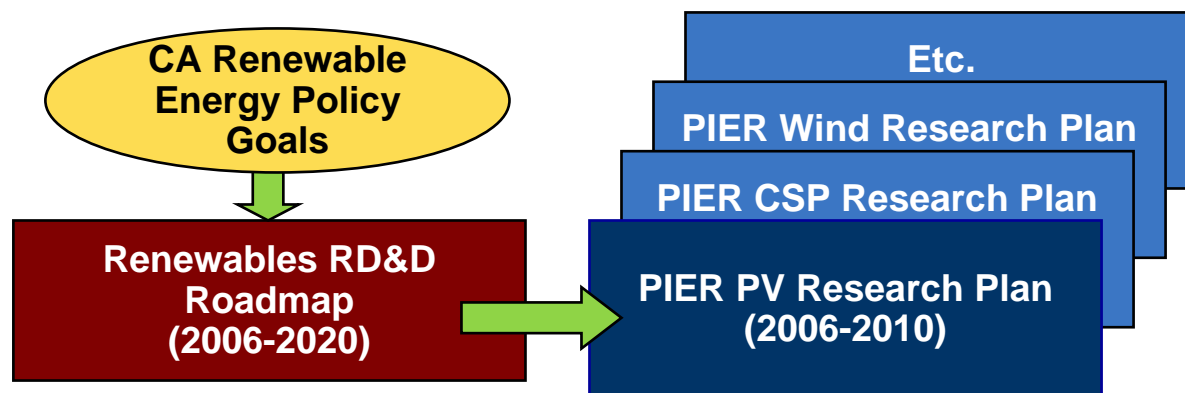
- Communicate and involve key stakeholders in the process to develop the PIER Photovoltaic (PV) research plan
- Provide an overview of the RD&D activities at the California Energy Commission and the Public Utilities Commission
- Present and receive feedback on the PV RD&D milestones between 2006 and 2020
- Present and receive feedback on the prioritization of RD&D milestones

Earlier this year, PIER Renewables developed an integrated Renewables RD&D Roadmap to identify the RD&D required to help CA meet policy goals.



- Encompasses most renewable energy resources/technologies viable between 2006-2020 (e.g. wind, biomass, solar PV, solar CSP, geothermal, wave/tidal/ocean, small hydro).
- Long-term view (15 years)
- Broad perspective of RD&D needed to help California meet key renewable energy policy goals
- Includes RD&D to be supported by PIER and many others (e.g. private industry, government laboratories)
- Integrates the input of over 50 external stakeholders

To prioritize the RD&D milestones in the roadmap, PIER Renewables is working with stakeholders to develop plans by technology/resource area.



- Focus on each resource/technology area separately
- Collaborate closely with CEC Renewables Energy Program, CPUC and IOUs, as all have RD&D needs related to implementing CSI and SB1
- Engage key stakeholders, (internal and external to Commission), for prioritizing RD&D to be supported by PIER Renewables

PIER Renewables formed a Steering Committee to guide the development of the PV Research Plan.

Steering Committee Members	
Organization	Name
Energy Commission Renewable Energy Program	Bill Blackburn
Commissioner Geesman's Office	Suzanne Korosec
Commissioner Pfannenstiel's Office	Tim Tutt
California Public Utilities Commission	Jeanne Clinton Jaclyn Marks
PIER Director	Martha Krebs
PIER Generation Office Manager	Elaine Sison-Lebrilla
PIER PV Program Manager	Golam Kibrya

Role of the Steering Committee:

- Lead the development of the PIER PV Research Plan
 - Provide input to approach and process
 - Review draft documents prepared for stakeholders or Commissioners
 - Participate in decision making meetings
- Be champions of the PV Research Plan inside of the Commission and outside with key stakeholder groups

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3:45 pm – 4:15 pm

PIER Renewables advances and accelerates market adoption of renewable energy technologies that are key to meeting State energy policy goals.

- About PIER Renewables
 - The Public Interest Energy Research Program (PIER) was established in 1996 as part of new legislation that provides \$62.5 million from investor-owned utility ratepayers for "public interest" energy research and development efforts that are not adequately provided for by competitive and regulated markets.
 - PIER is divided into seven program areas, one of which is PIER Renewables
 - Between July 1, 2000 through June 30, 2005, PIER Renewables invested \$53.6 million in RD&D projects.
- RD&D Focus
 - Advancing market adoption of renewable energy resources and generating technologies through innovation, performance improvements and cost reduction, as well as advancing the production of transportation fuels with renewable resources
 - Enabling effective interconnection of renewable generation to the electrical transmission and distribution system
 - Encouraging end-user adoption of distributed renewables by addressing technology and market issues
 - Supporting development of appropriate market mechanisms and policies to enable sustainable renewable energy growth

Renewable Energy Program

New Account

- Of the 69 active projects, 47 have been completed and are producing electricity representing 488 MW of capacity

Existing Renewable Resources

- Has helped 275 existing renewable facilities remain competitive or return to service by paying more than \$225 million for 4,400 MW of renewables capacity

Emerging Account

- Eligible technologies: solar photovoltaic, small wind, fuel cells using renewable fuels, solar thermal electric.
 - ✓ Provided \$253 million for distributed PV and wind energy systems installed on 17,100 homes and businesses, providing 71 MW of capacity.
 - ✓ Encumbered \$74 million for 4,600 additional systems under construction, to provide 25.5 MW.

Consumer Education

- Provided \$5 million for market research, 21 outreach and demonstration grant projects, and 2 public awareness campaigns.

Continued...

California Solar Initiative

- \$2.9 billion in rebates offered over a 10-year period
- Goal of 3,000 MW of installed solar capacity by 2017 (currently focused on PV)
- New Solar Homes Partnership 400 MW Goal.

Western Renewable Energy Generation Information System (WREGIS)

- A voluntary, independent renewable energy registry and tracking system for the Western Interconnect region

California's Renewables Portfolio Standard (RPS)

- Governor Schwarzenegger's goal is 33% by 2020.

CPUC'S Solar Audience

- Existing residential buildings
 - Single-family homes
 - Low-income / affordable housing
 - Multi-family apartments
- All commercial buildings
 - Schools
 - Government buildings
- All industrial facilities
 - Warehouses
 - Manufacturing
- All agricultural facilities



Panels on an existing home



California State University – East Bay

Note: The CEC's New Solar Homes Partnership covers **new** residential construction.

CPUC's Vision for Solar Research, Development, Demonstration & Deployment

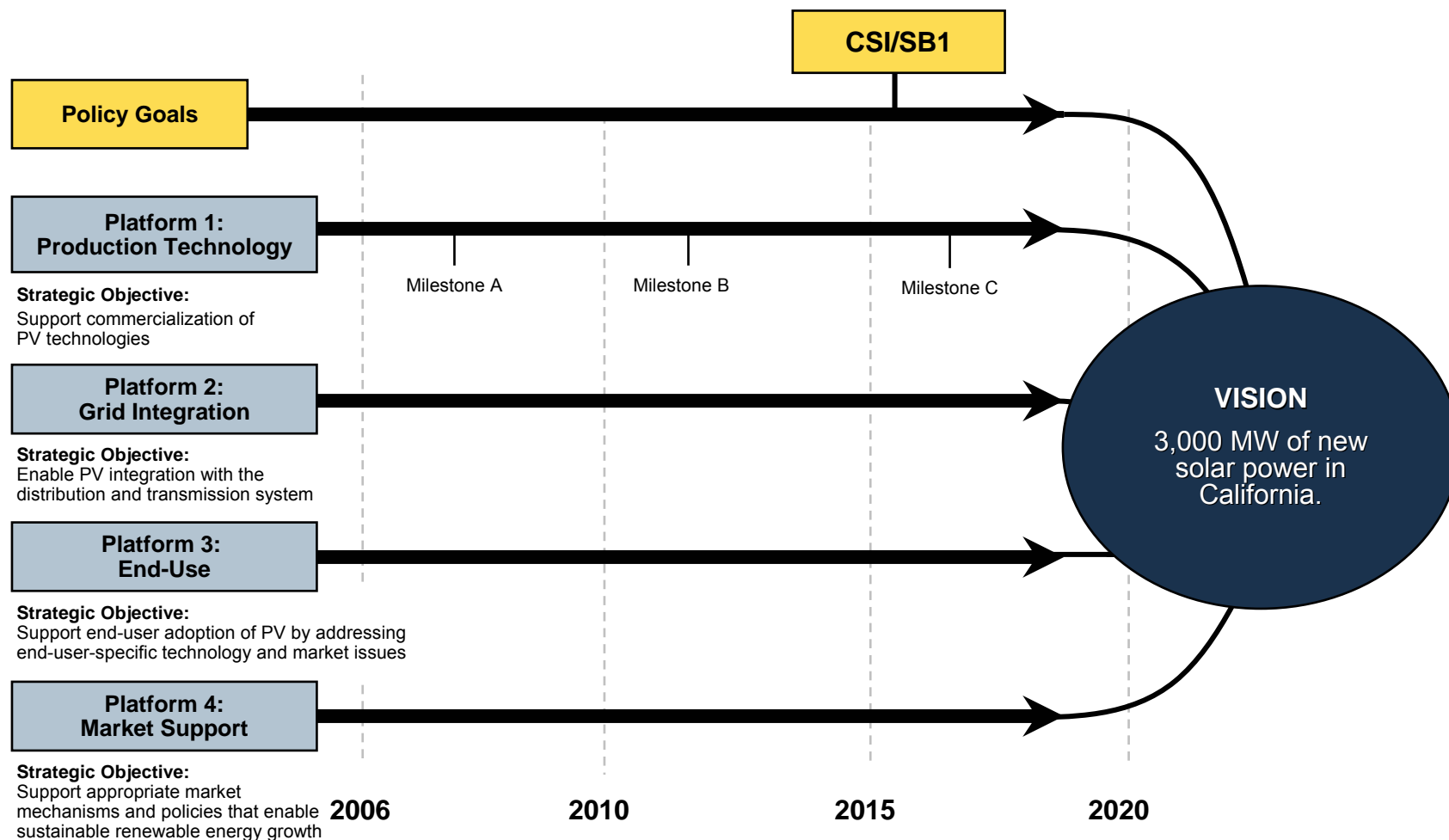
- Budget
 - CPUC authorized to spend \$50 million over 2007-2016 to support on-site solar technology deployment
- End Goal
 - Quality, high performance systems installed at prices competitive with retail electricity costs to achieve 3,000 solar MW statewide goal
- Key Principles
 - Expand beyond traditional R&D to support demonstration (of new technology performance) & deployment strategies (new business models, delivery channels, financing or guarantee arrangements)
 - Fill gaps in funding and needs unique to California or its goals
 - Focus on commercial-stage solar technologies
 - Fund application-oriented market development
- Process
 - Leverage insights from CEC's PIER solar stakeholder analysis
 - Coordinate plans of CEC, USDOE, and other funding sources
 - Define metrics to evaluate and choose among opportunities
 - Engage public input and ensure transparent decisions

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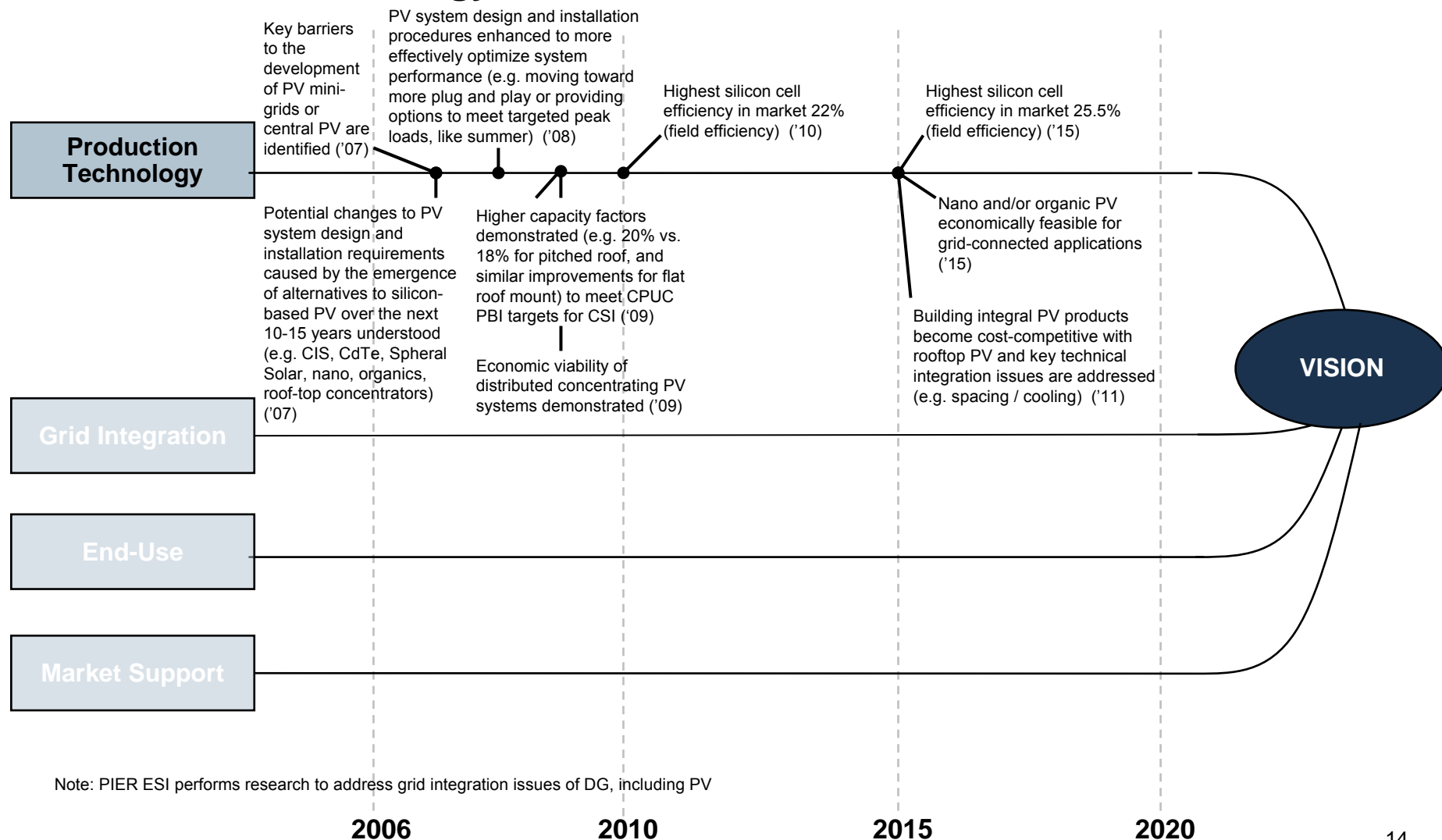
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The PV Roadmap lays out the PV RD&D required to meet key PV policy goals in CA. The PIER PV Research Plan will be a prioritized sub-set.

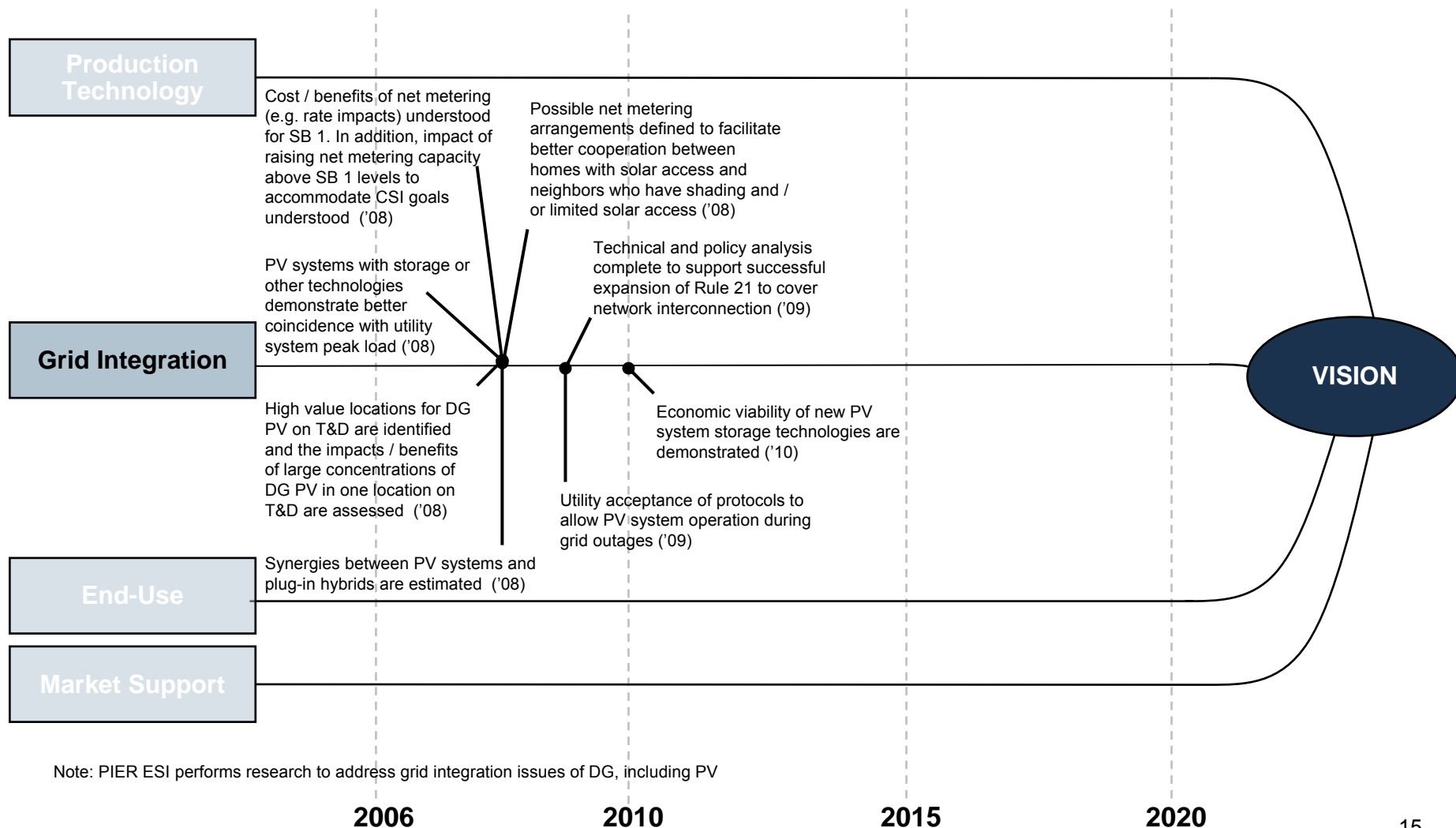


PV RD&D Roadmap Platform 1: Production Technology

This page contains the PV RD&D activities PIER is considering in the Production Technology area.

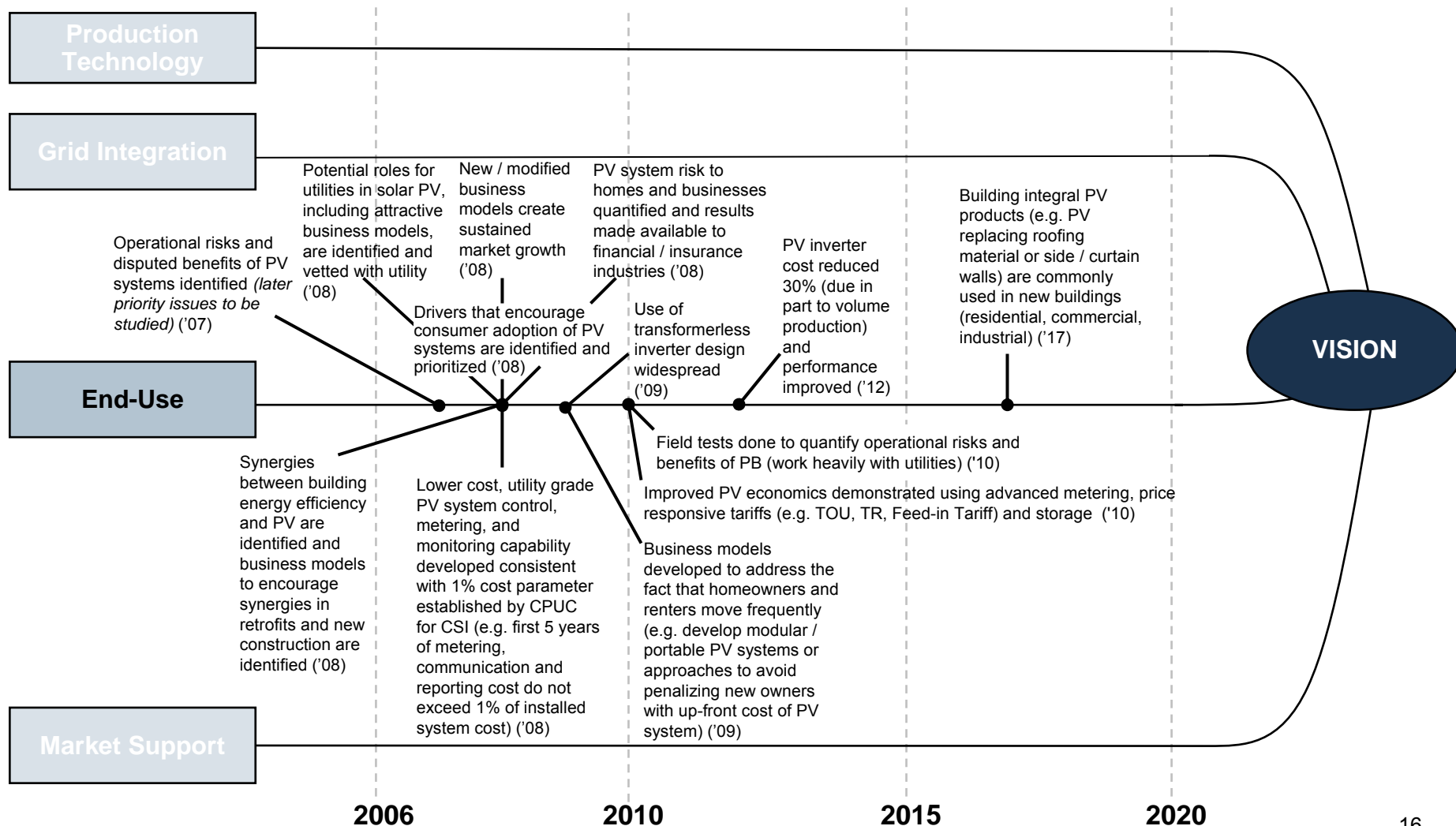


This page contains the PV RD&D activities PIER is considering in the Grid Integration area.

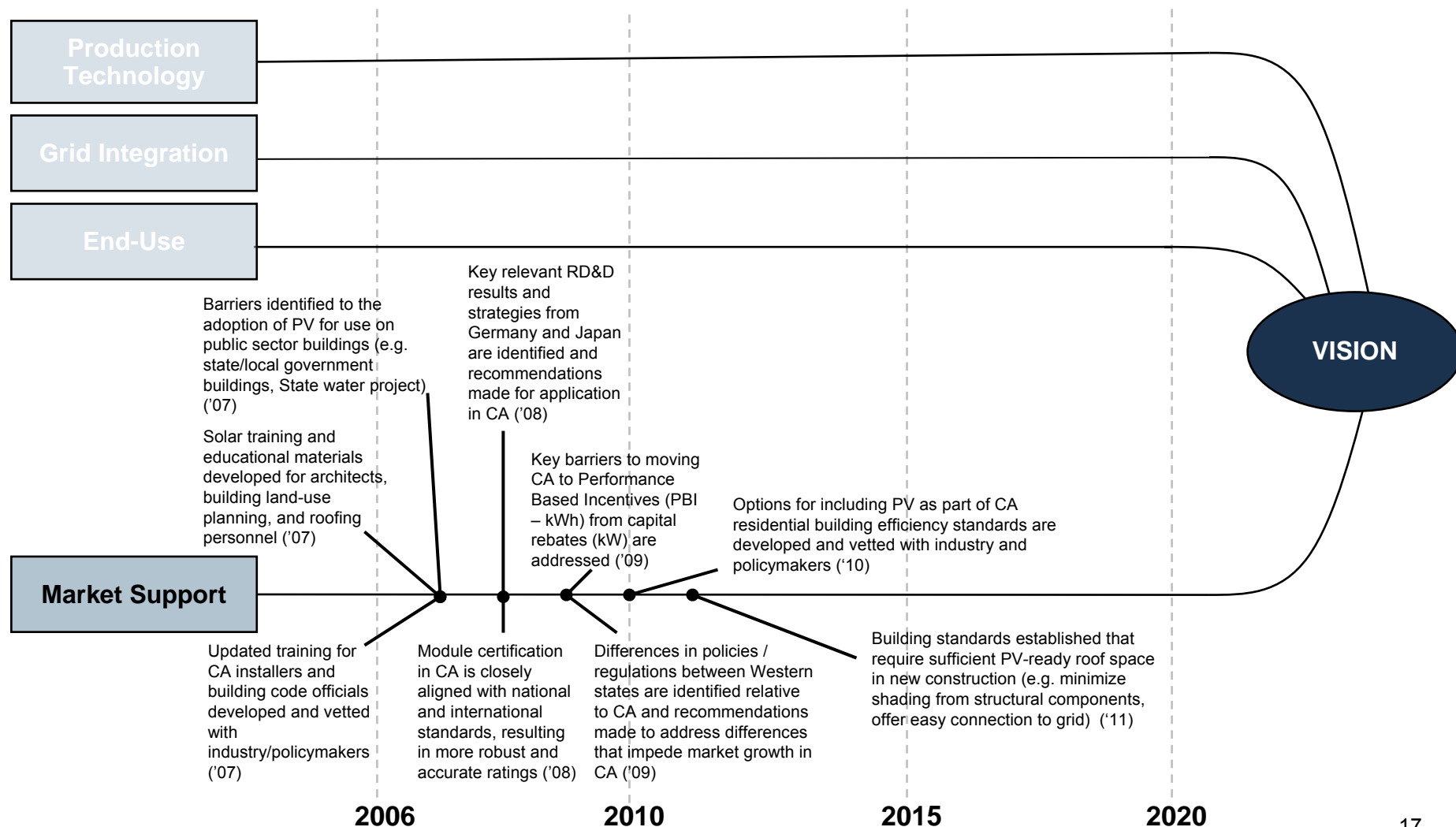


PV RD&D Roadmap Platform 3: End Use

This page contains the PV RD&D activities PIER is considering in the End Use area.



This page contains the PV RD&D activities PIER is considering in the Market Support area.



During the prioritization interviews, stakeholders suggested a number of new milestones for PIER that were not identified on the original roadmap.

Yr	High Priority Milestones [score]	No.
'13	<u>Production Technology</u> : DC home demonstrated to eliminate inverter and have higher efficiency PV system [N/A]	P10
N/A	<u>Production Technology</u> : Lifecycle economic and environmental evaluation of PV technologies to determine most effective paths (e.g. to determine waste, energy input)	P11
'08	<u>End-Use</u> : Consumer behavior with respect to maintenance and repairs of PV systems and impact on system performance is understood (e.g. issues of regular maintenance like cleaning off dust, and reaction to inverter failure) [4,4]	E14
'09	<u>End-Use</u> : Develop business models for multi-use residential buildings including low income residential [4,4]	E15
'08	<u>Market Support</u> : Develop unified PV permitting procedures developed for California and vetted with city officials [3,3]	M10
'09	<u>Market Support</u> : Best practices for PV system installation are identified in Germany and Japan and integrated into installer training and materials [N/A]	M11
'10	<u>Market Support</u> : Successful PV technologies from Germany, Japan and other leading PV markets, including storage and balance of system technologies, with high potential to impact CA PV market demonstrated [4,5]	M12
'10	<u>Market Support</u> : Clear understanding is achieved of where large solar fits in to the utility power structure e.g. how PPAs are structured and valued for a large PV plant (time of use, capacity credit to count on etc.) [5,5]	M13

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PV RD&D Priorities for PIER Prioritization Interviews

PIER completed prioritization interviews with 17 selected stakeholder organizations.

List of Interviews					
No.	Organization	Contacts	No.	Organization	Contacts
1	Commission Renewables	Bill Blackburn, Emerging Renewables Program; Sandy Miller, Solar Program	10	Vote Solar	JP Ross, Policy Director
2	CPUC Staff	Jeanne Clinton, Clean Energy Advisor; Jaclyn Marks, Regulatory Analyst	11	Clean Energy States Alliance	Mark Sinclair, Clean Energy Group; Lew Milford, Executive Director
3	CPUC Leadership	Commissioner Peevey	12	Consol	Rob Hammon, Principal
4	PG&E	Hal LaFlash, Director Renewable Energy Policy & Planning; Bruce Bowen, Director of Regulatory Policy	13	CALSEIA	Les Nelson, Executive Director; Barry Cinnamon, President; Gary Gerber, Chair of Policy Committee
5	SCE	Stuart Hemphill, Director of Renewable and Alternative Power; Wil Grady, Technical Advisor Renewable and Alternative Power	14	SunPower	Dick Swanson, President & CTO
6	SDG&E	David Berokoff, Manager Technology Development; James D. Corlett, Sr. Technology Development Advisor	15	PowerLight	Brian Stone, VP Marketing; Jack Peurach, VP Product Development; Howard Wenger, Executive VP
7	SMUD	Jon Bertolino, Superintendent Renewable Generation Assets	16	NanoSolar	Brian Sager, VP Finance and Corporate Development
8	US DOE	Craig Cornelius, Technology Manager, Office of Solar Energy Technologies; Tom Kimbis, Technology Manager, Solar Technology Acceptance; Steve Chaulk, Acting Solar Program Manager	17	University of California, Merced	Roland Winston, Professor, School of Engineering and School of Natural Sciences
9	NREL	Robert Margolis, Senior Energy Analyst			

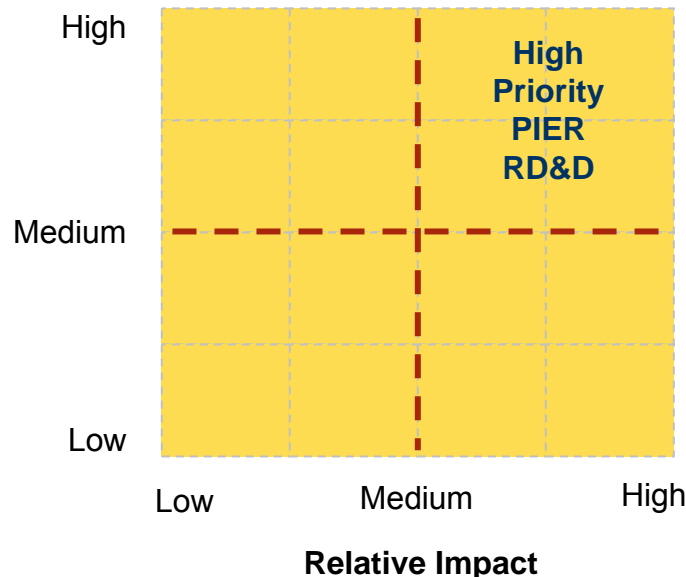
During the interviews, PIER Renewables asked stakeholders to prioritize RD&D needs based on relative impact and need for PIER funding.

Prioritization Criteria for PIER Solar PV RD&D

Relative Need for PIER Renewables to Fund RD&D

What is the relative size of the gap between the RD&D required and recent RD&D activity funded by:

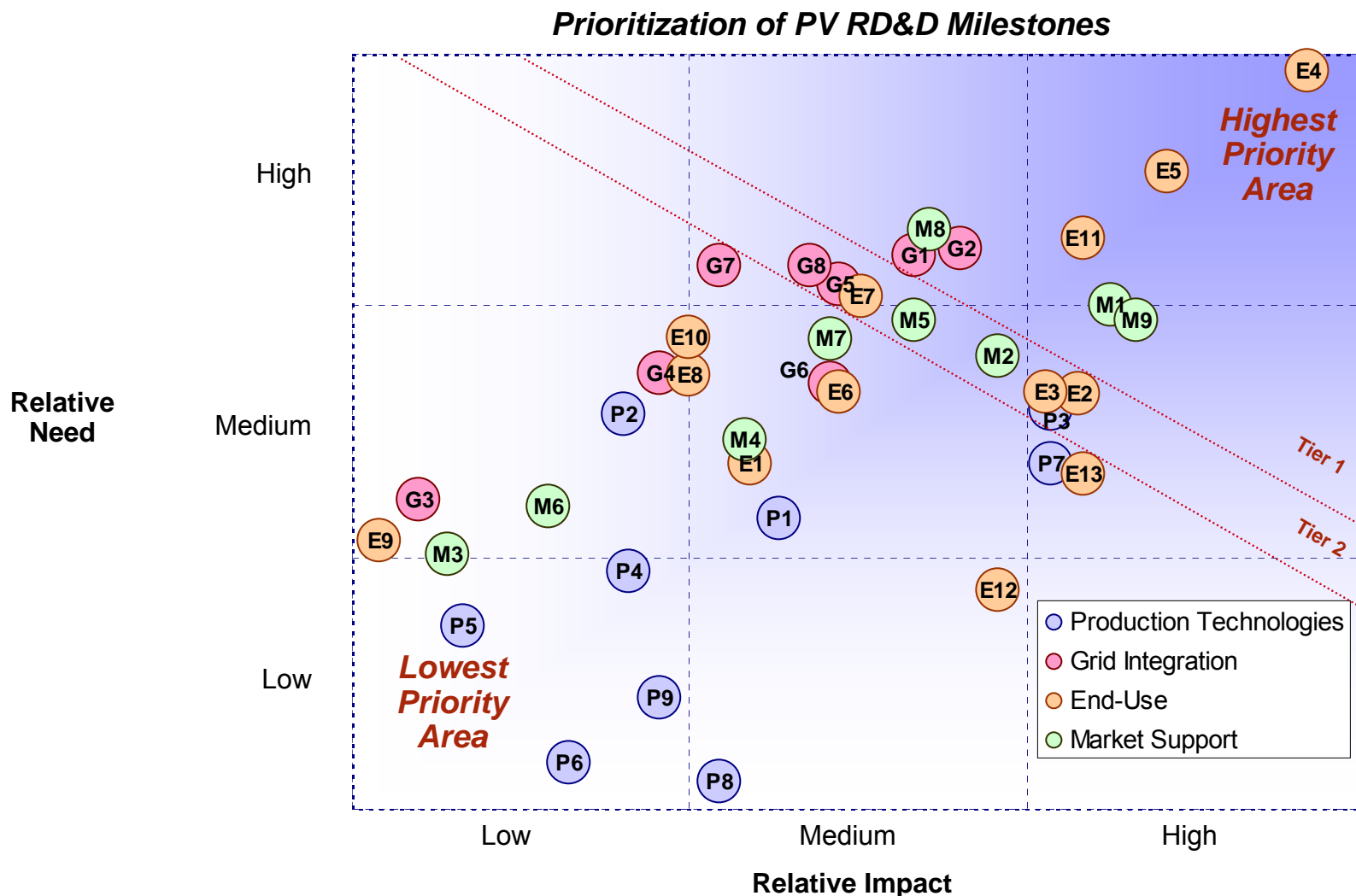
- PIER Renewables or other groups in the Commission
- DOE and national laboratories
- Universities
- Private industry



How important is the RD&D in encouraging PV adoption to meet key State solar PV policy goals? (e.g. CSI and SB1)

PV RD&D Priorities for PIER Prioritization Results

The analysis revealed that the eight highest ranking milestones (i.e., tier 1) are from the *End-Use, Market Support, and Grid Integration* platforms.



PV RD&D Priorities for PIER Prioritization Results



Platform	Number	Year	Milestone Description
Production Technology	P1	'07	Potential changes to PV system design and installation requirements caused by the emergence of alternatives to silicon-based PV over next 15 yrs understood
	P2	'07	Key barriers to the development of PV mini-grids or central PV are identified
	P3	'08	PV system design and installation procedures enhanced to more effectively optimize system performance
	P4	'09	Higher capacity factors demonstrated (e.g. 20% vs. 18% for pitched roof, and similar improvements for flat roof mount) to meet CPUC PBI targets for CSI
	P5	'09	Economic viability of distributed concentrating PV systems demonstrated
	P6	'10	Highest silicon cell efficiency in market 22% (field efficiency)
	P7	'11	Building integral PV products become cost competitive with rooftop PV and key technical integration issues are addressed (e.g. spacing/cooling)
	P8	'15	Highest silicon cell efficiency in market 25.5% (field efficiency)
	P9	'15	Nano and/or organic PV economically feasible for grid-connected applications
Grid Integration	G1	'08	Cost/benefits of net metering (e.g. rate impacts) understood for SB1, as well as impact of raising net metering capacity to accommodate CSI goals
	G2	'08	PV systems with storage or other technologies demonstrate better coincidence with utility system peak load
	G3	'08	Possible net metering arrangements defined to facilitate cooperation between homes with solar access and neighbors who have shading and/or limited access
	G4	'08	Synergies between PV systems and plug-in hybrids are estimated
	G5	'08	High value locations for DG PV on T&D are identified and the impacts/benefits of large concentrations of DG PV in one location on T&D are assessed
	G6	'09	Technical and policy analysis complete to support successful expansion of Rule 21 to cover network interconnection
	G7	'09	Utility acceptance of protocols to allow PV system operation during grid outages
	G8	'10	Economic viability of new PV system storage technologies are demonstrated
End-Use	E1	'07	Operational risks and disputed benefits of PV systems identified (later priority issues to be studied)
	E2	'08	Drivers that encourage consumer adoption of PV systems are identified and prioritized
	E3	'08	New/modified business models create sustained market growth
	E4	'08	Synergies between building energy efficiency and PV are identified and business models to encourage synergies in retrofits and new construction are identified
	E5	'08	Potential roles for utilities in solar PV, including attractive business models, are identified and vetted with utility companies.
	E6	'08	PV system risk to homes and businesses quantified and results made available to financial / insurance industries
	E7	'08	Lower cost, utility grade PV system control, metering, and monitoring capacity developed consistent with 1% cost parameter established by CPUC for CSI
	E8	'09	Use of transformerless inverter design is widespread
	E9	'09	Business models developed to address fact that homeowners and renters move frequently
	E10	'10	Field tests done to quantify operational risks and benefits of PV (work heavily with utilities)
	E11	'10	Improved PV economics demonstrated using advanced metering, price responsive tariffs (e.g. TOU, Feed-in Tariff) and storage
	E12	'12	PV inverter cost reduced 30% (due in part to volume production) and performance improved
	E13	'17	Building integral PV products (e.g. PV replacing roofing material or side/curtain walls) are commonly used in new buildings (residential, commercial, industrial)
Market Support	M1	'07	Updated training for CA installers and building code officials developed and vetted with industry/policy makers
	M2	'07	Solar training and educational materials developed for architects, building land-use planning, and roofing personnel
	M3	'07	Barriers identified to the adoption of PV for use on public sector buildings (e.g. state/local government buildings, State water project)
	M4	'08	Key relevant RD&D results and strategies from Germany and Japan are identified and recommendations made for application in CA
	M5	'08	Module certification in CA is closely aligned with national and international standards, resulting in more robust and accurate ratings
	M6	'09	Differences in policies/regulations between Western states are identified and recommendations made to address differences that impede market growth in CA
	M7	'09	Key barriers to moving CA to Performance Based Incentives (PBI - kWh) from capital rebates (kW) are addressed
	M8	'11	Building standards established that require sufficient PV-ready roof space in new construction
	M9	'10	Options for including PV as part of CA residential building efficiency standards are developed and vetted with industry and policy makers

Overall scores suggest that PIER should focus PV RD&D efforts primarily on *End-Use*, *Market Support* and *Grid Integration*.

- Out of the top eight list of priority milestones (i.e., tier 1):
 - Three are from *End-Use*
 - Three are from *Market Support*
 - Two are from *Grid Integration*
 - None are from *Production Technologies*
- Most milestones in the *Production Technologies* platform have a low need score as stakeholders believe PIER should not play a role in production technologies, as industry and DOE are focused on this area.
- Most milestones in the *Grid Integration* platform have a high need score, as stakeholders believe that PIER plays an important role in this area. However, these milestones received lower impact scores.
- In the *End-Use* and *Market Support* platforms, milestones ranged widely in importance and need.

PV RD&D Priorities for PIER Tier 1 Priority Milestones



The Steering Committee added a production milestone to the tier 1 group.

Number	Year	Milestone Description	Comments from Steering Committee
E4	'08	Synergies between building energy efficiency and PV are identified and business models to encourage synergies in retrofits and new construction are identified	<ul style="list-style-type: none"> • Much research already available for new construction EE and PV • Need to understand retrofits better, as well as synergies between EE and PV • Need to coordinate with PIER Buildings
E5	'08	Potential roles for utilities in solar PV, including attractive business models, are identified and vetted with utility companies	<ul style="list-style-type: none"> • CEC Renewables has contract with MRW to address this issue • PIER should continue research after MRW work is completed • PIER ZENH and PV Market Assessment work supports this issue • Focus on how to make it work for IOUs and end-users over the long run
E11	'10	Improved PV economics demonstrated using advanced metering, price responsive tariffs (e.g. TOU, TR, Feed-in Tariff) and storage	<ul style="list-style-type: none"> • Important issue, and there is not much research going on • Need to understand how advanced metering can benefit PV system economics and IOUs
M1	'07	Updated training for CA installers and building code officials developed and vetted with industry/policy makers	<ul style="list-style-type: none"> • Will be addressed by CEC Renewable Energy Program as part of incentive package for builders • CPUC might complement with training for non-builder stakeholder groups • Potential PIER role in developing training "needs assessment"
M9	'10	Options for including PV as part of CA residential building efficiency standards are developed and vetted with industry and policy makers	<ul style="list-style-type: none"> • Effort started a year ago for '08 new construction standards (PV optional) • PIER buildings already supporting development of Title 24 building standards • Need to assess feasibility of requiring builders to offer PV (SB1 requirement)
M8	'11	Building standards established that require sufficient PV-ready roof space in new construction	<ul style="list-style-type: none"> • Part of '11/'12 standards, not '08 standards • Need to study not only roof, but integration to other building materials
G2	'08	PV systems with storage or other technologies demonstrate better coincidence with utility system peak load	<ul style="list-style-type: none"> • IOUs have expressed importance of this issue, but not doing much research • Supported by PIER ESI work with inverters • PIER IAW putting together storage RD&D effort • E11 is an economic assessment, while G2 is technology development
G1	'08	Cost/benefits of net metering (e.g. rate impacts) understood for SB1, as well as impact of raising net metering capacity to accommodate CSI goals	<ul style="list-style-type: none"> • Limited role for PIER, as CPUC has legislative mandate to cover this issue through their program evaluation efforts
P3	'08	PV system design and installation procedures enhanced to more effectively optimize system performance	<ul style="list-style-type: none"> • Milestone moved from tier 2 to tier 1 priority by Steering Committee, given input from stakeholder roundtable, but industry should be doing some of this already • Need to pay more attention to reducing installation cost

PV RD&D Priorities for PIER Tier 2 Priority Milestones

The tier 2 group is also formed by milestones from *End-Use, Market Support* and *Grid Integration* platforms.

Number	Year	Milestone Description	Comments from Steering Committee
M2	'07	Solar training and educational materials developed for architects, building land-use planning, and roofing personnel	<ul style="list-style-type: none"> As with M1, CEC Renewables and CPUC plan to address this issue Limited role for PIER (e.g., developing training needs assessment)
E2	'08	Drivers that encourage consumer adoption of PV systems are identified and prioritized	<ul style="list-style-type: none"> CEC Renewables planning to address this issue, focused on new residential construction (budget of \$4.5 MM over next three years) Could fit with CPUC marketing and outreach efforts, priorities not yet defined PIER can support with market research piece
M5	'08	Module certification in CA is closely aligned with national and international standards, resulting in more robust and accurate ratings	<ul style="list-style-type: none"> Module certification will be part of CEC Renewables work on installation handbook (focused on new construction) In the New Solar Home Guidebook, there are guidelines. CA is moving toward STC, and the PTC rating will likely not be used. The Self Gen program provides a certified equipment list. CPUC will likely coordinate with CEC on this. CPUC expects CEC to address this issue (as per SB1), also for retrofits
G5	'08	High value locations for DG PV on T&D are identified and the impacts/benefits of large concentrations of DG PV in one location on T&D are assessed	<ul style="list-style-type: none"> PIER Renewables has looked at this issue for all renewables on transmission; work can be extended to cover PV on distribution system PIER ESI has funded work to demonstrate locational benefits of DG on distribution systems
G8	'10	Economic viability of new PV system storage technologies are demonstrated	<ul style="list-style-type: none"> Complements storage issues in milestones E11 and G2 (both tier 1), but this has a broader storage technology focus
E7	'08	Lower cost, utility grade PV system control, metering, and monitoring capacity developed consistent with 1% cost parameter established by CPUC for CSI	<ul style="list-style-type: none"> CPUC assumes market will work this out under CPUC program rules and handbook working group. Will evolve quickly in market over next year.
E3	'08	New/modified business models create sustained market growth	<ul style="list-style-type: none"> Compliments work in milestone E5 (tier 1)
G7	'09	Utility acceptance of protocols to allow PV system operation during grid outages	<ul style="list-style-type: none"> If the value of solar during grid outages is incorporated, it would have ranked higher. Scored low as consumer today assumes PV will be available during grid outage, even though this is false.

PIER will also take into account other issues raised by stakeholders during the interviews and roundtable as it implements RD&D priorities.

Stage of Technology Development

- Focus on later stage demonstration projects, not on early research.
- Play a role in helping to get products over the last commercialization hurdles and into the market

Coordination

- Coordinate and complement RD&D from other State solar funds (e.g., CPUC RDD&D, marketing & outreach, program evaluation).
- Focus on issues that are unique to CA and that are not being pursued by industry or government agencies.
- Play a role in informing policy as a neutral party.

Industry Support

- Capability to scale up should be considered as an important factor, help PV module manufacturers attract capital to scale up production facilities as well as installation capacity.
- Benchmark installation practices and costs from US, Japan, and Germany (consistent with P3 milestone).
- Select research projects based on their impact on reducing the total installed cost per kWh.
- Take advantage of the “natural experiment” in CA, especially with respect to grid integration.

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PIER Renewables will use the *PV Research Plan* to guide annual project funding decisions.

- Send any additional written comments by this Friday, November 17th to Elaine Sison-Lebrilla (esisonle@energy.state.ca.us).
- Today's input, as well as written comments, will be used to update the PV research plan.
 - The final PIER PV Research Plan report will be published during the next month.
- PIER Renewables will use the research plan in annual project planning to determine research funding.

Closing Comments

- Any comments about today's session?